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Towed Decoy and Method of Improving the Same

The present invention relates to a towed decoy and a method of improving the same. The invention has been developed in efforts of being able to use an existing towed decoy more efficiently by supplementing it in various ways. However, it will just as well be possible to correspondingly build a completely new towed decoy.

A towed decoy is a type of offboard decoy which is intended to generate an angular displacement in a threat system, especially towards a homing device. The decoy is towed behind, for instance, an aircraft, and creates a false target which should be more powerful than the fuselage echo. When using a towed decoy, it is important to obtain an angle separation between the target and the decoy. Some kind of manoeuvre is usually required from the aircraft.

Not only aircraft but also vessels may have a towed decoy. However, such decoys are themselves more manoeuvrable than in the case of aircraft. The invention will be presented below with examples involving an aircraft. Equivalent examples may be used for vessels, and a restriction of the scope of protection as a result of the examples is not intended.

There are two types of towed decoy, one in which a complete repeater is implemented in the towed body and one where the towed body comprises a transmitter part only. In this case the signal is supplied from the aircraft.

In the first case, the threat signal is received in the towed body. The decoy then repeats incoming signals and generates a decoy, the size of which depends on the total loop gain in the system. Some kind of amplitude or phase modulation may occur.

In the second case, development of towed decoys is going on all over the world, which receive an RF signal via a fibre optical link from the decoy of the aircraft (mounted inboard or outboard). The problem with insulation between the antennas then decreases drastically, which allows a greater target area to be generated and thus to give greater safety that the decoy attracts the missile. A further advantage is that the decoy of the aircraft normally is more advanced and has a greater selection of forms of jamming. The towed body further comprises fewer electronics in this

case, which keeps the cost down, especially if the towed body is hit by the missile or is lost in some other way.

The invention gives an advantageous alternative which besides implies that it is easy to supplement older towed decoys of the first type and give them highly improved qualities. This takes place by the invention having the features that are evident from the independent claim. The remaining claims define suitable embodiments of the invention.

In the following the invention will be described in more detail with reference to the accompanying drawing in which

Fig. 1 shows an irradiated towed decoy for aircraft according the invention, and
Fig. 2 is a block diagram of an embodiment of the invention.

The inventive towed decoy arrangement for a craft 20 comprises a decoy 21 towed by the craft. Fig. 1 shows what it may look like in the case of aircraft. Fig. 2 shows how the arrangement can be composed. In the craft, here the aircraft, there is an antenna 1 for receiving threatening signals, such as radar pulses, and an analysis and noise signal generating device 2 for self protection. It may either be built in or carried as a pod on a pylon. The generated noise signal is transformed to a frequency which is rapidly attenuated in air and differs from the frequency of the threatening signal. That signal is sent through an antenna 5 to the towed decoy.

The towed body (decoy) is provided with an antenna 6 receiving the signal from the antenna 5 of the craft and a device 7, 8, 9, 10, 11 transforming the received signal back into a noise signal by shifting it to the frequency of the threatening signal. This signal proceeds to an actual decoy transmitter 12 with an antenna 13 for transmitting the noise signal in the direction of the source of the threat signal. Starting from of an older towed decoy of the first type as described above, the latter actual decoy transmitter and the antenna can be the decoy transmitter with antenna that has been used up till now.

Fig. 2 also shows a more concrete example of how a system according to the invention can be designed. The generated noise signal is supplied to a mixer 3 which is connected to a local oscillator 4. The antenna 5 is connected to the third port of the

mixer 3. The signal received by the antenna 6 is divided in a power divider 7. One branch is used to regenerate the local oscillator signal via a band-pass filter 8. The filter has a pass band at the frequency of the LO signal and a bandwidth which lets the LO signal pass, but blocks the mixed signal. The regenerated LO signal is amplified in an amplifier 9 and is then fed to a mixer 10. In the mixer, the regenerated LO signal is mixed with the transferred signal from the second port of the power divider. The signal from the mixer is filtered in a low-pass filter 11, and the original signal is regenerated and passed to the actual towed decoy transmitter 12.

The absolutely greatest risk of using an irradiated towed decoy is that the threat can be locked to the signal from the aircraft to the towed body or strong side lobes from the signal. To eliminate this threat, first another frequency for the transmission is used than the frequency of the current threat. The most convenient measure is to convert the signal up in frequency. It is an obvious advantage if the frequency band for the transmission is clearly outside conventional frequency bands for warning systems. Another measure that reduces the risk that the signals between the craft and the towed body will be caught by the threat is to use signals that are rapidly attenuated in air, a typical value being an attenuation by at least 1 dB/km.

It is known that the atmosphere contains different frequency bands with different propagation attenuations. Among frequency bands with good transmission (low attenuation) mention can be made of the various radar bands (L,S,C,X,Ku), certain parts of the mm waveband (26 –200 GHz), and also IR bands.

A special frequency band around 60 GHz is of interest for opposite reasons. Attenuation is particularly high for this band and allows only short communication distances between transmitter and receiver at this frequency. The millimetre waveband above 58 GHz is of interest for use of links that are difficult to detect, but there are not very many components on the market. This means that the few components that are available are usually very expensive. Also higher frequencies are of interest, since monitoring systems operating at these high frequencies are most unusual.

A further advantage of the millimetre waveband is that the transmitted bandwidth is great in absolute bandwidth, but small as relative bandwidth. The bandwidth that is probable in a tactical scenario is between 8 and 18 GHz. 10 GHz at 77 GHz means a relative bandwidth of 13%, which is not very much. As comparison, the relative

bandwidth for a 10 GHz signal at the X and Ku band is about 77%. The limited relative bandwidth implies, inter alia, that a system may be fairly flat in frequency response etc.

The band around 77 GHz is also special since it is used for car radar and therefore hardware is becoming available at competitive prices. In a particularly advantageous embodiment of the invention, a signal of the frequency 77 ± 5 GHz is therefore used.

An important parameter regarding the radiating antenna is the lobe width. Of course, it must be ensured that the lobe lies on the towed body. At the same time, it is desirable not to propagate signals more than necessary. For a given aperture size, it is generally so that the higher the frequency, the narrower is the lobe. For 77 GHz, the aperture will be very small, which is a great advantage for the towed target.

The amplification for an antenna can be calculated when the lobe angles are known using the following formula (rule of thumb):

$$G \approx \frac{30000}{\theta_{az} \cdot \theta_{el}}$$

θ_{az} *Beam width in azimuth* $[°]$

θ_{el} *Beam width in elevation* $[°]$

With values inserted for antenna coverage of ±10° in each plane an antenna gain of about 18 dB is obtained.

The amplification for horn antennas is calculated using the following formula:

$$A_{eff} = \frac{\lambda^2 \cdot G}{4\pi \cdot \eta}$$

A_{eff} *Effective antenna area*

λ *Wavelength*

G *Antenna gain*

η *Antenna efficiency (about 0.6 for square horn antennas)*

With inserted values for 77 GHz, the aperture area will be about 1.5 cm^2.